COELIAC TRUNK BRANCHING PATTERN AND VARIATION

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ABSTRACT

BACKGROUND

Anatomical variations involving the visceral arteries are common. However, variations in coeliac trunk are usually asymptomatic, they may become important in patients undergoing diagnostic angiography for gastrointestinal bleeding or prior to an operative procedure. This study was useful for knowing the possible morphological variations before an upper abdominal surgery.

MATERIALS AND METHODS

This was a descriptive study done by cadaveric dissection, conducted on thirty cadavers. The coeliac trunk being examined for its origin, branching pattern, distribution, and variations. Results were statistically analysed and compared with the previous studies.

RESULTS

In our study, 60% of the coeliac trunk shows variations and 40% have normal branching pattern. A complete absence of coeliac trunk was observed in one case. In the present study the Right inferior phrenic artery arising from coeliac trunk in 2 cases (6.6%) and left inferior phrenic artery arising from coeliac trunk in 3 cases (9.9%). Both inferior phrenic arteries are arising from coeliac trunk in 2 cases (6.6%). The common hepatomesenteric trunk and gastro splenic trunk was found in 1 case (3.3%). Hepatosplenic trunk was found in 2 cases (6.6%). In another 2 cases (6.6%) gastric and hepatic artery originate from coeliac trunk but splenic artery has a separate origin from abdominal aorta. An absent trunk was also found in 1 case (3.3%). In 5 cases (16.7%) showed trifurcation with variation in the branching pattern.

CONCLUSION

The branching pattern and extreme degree variability in coeliac trunk as brought out in the observations of the present study make it obvious that the present study almost falls in description with previous studies.

KEYWORDS

Coeliac Trunk, Left Gastric Artery, Splenic Artery, Common Hepatic Artery.

HOW TO CITE THIS ARTICLE: Thomson JJ, Narayanan VK, Padmanabhan U, et al. Coeliac trunk branching pattern and variation. J. Evid. Based Med. Healthc. 2017; 4(7), 332-336. DOI: 10.18410/jebmh/2017/63

BACKGROUND

Galen was the first anatomist to examine in the detail the arterial system from the coeliac trunk, leading to the stomach, liver, spleen and pancreas. Jacques Benigne Winslow and Albert Haller considered the father of modern angiology, correctly defined the anatomy of coeliac trunk. Winslow completely described the trunk and its branches and Haller addressed the anatomical details of the anomalous hepatic artery. In certain cases coeliac trunk has been found to be absent.[1] The coeliac trunk may vary in its length, diameter, and branching pattern.[2] In some cases inferior phrenic arteries are directly arising from the coeliac trunk. The coeliac artery may compressed by median arcuate ligament. The knowledge of variation of inferior phrenic artery origin shows that surgeons must be cautious to avoid unintentional sectioning of small calibre arteries, as it may occur during the coeliac artery decompression.

A precise knowledge of the variations in the coeliac trunk is indispensable for surgical techniques like liver transplantation, cholecystectomy, and emerging case of bariatric surgery.[3] Cystic artery is notoriously known to have a highly variable branching pattern and relation to biliary ducts. So it is of utmost importance that the surgeon must be aware of the possible arterial and biliary variants in order to minimize surgical mishaps during laparoscopic cholecystectomy. The knowledge of coeliac trunk is very important during pancreatic resection also. So the clinical relevance as well as embryological and phylogenic aspects make coeliac trunk and its variation worth studying. The origin of the coeliac trunk lies behind the omental bursa surrounded by the coeliac plexus of nerves. It was sandwiched between the tuber omentale of the pancreas

Financial or Other, Competing Interest: None.
Submission 02-01-2017, Peer Review 09-01-2017,
Acceptance 19-01-2017, Published 20-01-2017.
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DOI: 10.18410/jebmh/2017/63

and papillary process of the liver. The trunk of the artery is short and proceeds forwards and slightly to the right. The most common classical type of branching of celiac trunk was known as trifurcation and first described by Haller in 1756 as tripus halleri. It was considered to be the normal branching pattern of the artery and the three main branches are left gastric artery (LGA), common hepatic artery (CHA) and splenic artery (SA). The branches of the arteries supplies all the organs derived from foregut, hence called artery of the foregut.

MATERIALS AND METHODS

This was a descriptive study done by cadaveric dissection, conducted on thirty cadavers.

Inclusion Criteria

The cadavers embalmed available from the Govt. Medical College, Kottayam, Kerala, after getting ethical clearance.

Exclusion Criteria

Damaged cadavers due to accidents and putrefaction.

METHODS

Expose the abdominal cavity by reflecting the anterior abdominal wall. Cut through the anterior layers of the greater omentum 2-3 cm inferior to the arteries to open the lower part of the omental bursa sufficiently to admit a hand. Explore the bursa. Pull the liver superiorly and lift its inferior margin anteriorly to expose the lesser omentum. Examine the right free margin of lesser omentum, containing the bile duct, proper hepatic artery and portal vein. Remove the anterior layer of peritoneum from the lesser omentum along the lesser curvature of stomach. Identify the short trunk of coeliac artery and its branches and further divisions.

OBSERVATIONS

The detailed observations of the coeliac trunk were compiled and subjected to statistical analysis. Out of the thirty cadavers examined, twelve cases (40%) showed normal trifurcation (Figure 1) and eighteen cases (60%) showed remarkable variations. One among these variants showed total absence of coeliac trunk.

The Normal Branching Pattern

The present study showed that the coeliac trunk is a short wide vessel of average 1.25 cm. Length and arises from the front of the aorta immediately below the aortic opening of the diaphragm. The origin of the coeliac trunk lies behind the omental bursa, and is surrounded by the coeliac plexus of nerves and sandwiched between the tuber omentale of the pancreas and the papillary process of the liver. The trunk of the artery proceeds forwards and somewhat to the right.

The left gastric artery is the smallest branch of the coeliac artery, but provides largest contribution to the stomach. It passes upwards and to the left towards the cardiac end of stomach, where it arches forwards along the superior gastropancreatic fold and reaches the lesser curvature of stomach. Within the lesser omentum the left gastric artery anastomoses with the right gastric artery. The left gastric artery provides a few ascending oesophageal branches to the cardiac orifice.

The common hepatic artery is larger and passes to the right behind the omental bursa, along the inferior gastropancreatic fold and reaches the right free margin of lesser omentum. Here the common hepatic artery provides origin to the right gastric, gastro-duodenal artery. Thereafter the common hepatic artery continues upwards within the free margin of lesser omentum and in front of the epiploic foramen as the hepatic artery proper which is accompanied with the portal vein posteriorly and the bile duct on its right side. Close to the porta hepatis the hepatic artery proper divides in to right and left branches which supply respectively the physiological right and left lobes of the liver. The right hepatic artery gives origin to cystic artery to supply the gall bladder. The cystic artery presents variations in the mode of origin which are of surgical interests. Calot's triangle is considered to be the important reference area for biliary surgeries and the cystic artery lies within the triangle.

The right gastric artery passes to the left within the lesser omentum along the lesser curvature of stomach and anastomoses with the left gastric artery.

The gastro-duodenal artery runs downwards behind the first part of duodenum. On reaching the lower border of duodenum the gastroduodenal artery divides into superior pancreatico duodenal and right gastroepiploic arteries. The superior pancreatico duodenal artery usually subdivides into anterior and posterior branches and anastomose respectively with the anterior and posterior branches of inferior pancreatico-duodenal arteries along the second part of the duodenum. The right gastro-epiploic artery passes along the greater curvature of stomach within the anterior two layers of greater omentum and anastomoses with the left gastro-epiploic branch of splenic artery. The gastroduodenal artery provides a supraduodenal branch (artery of Wilkie) which is an end-artery and supplies the upper margin and adjoining surfaces of proximal half of the first part of duodenum.

The splenic artery is the largest branch of the coeliac trunk and was slightly tortuous. The artery passes to the left behind the omental bursa along the upper border of the body and tail of the pancreas and reaches the hilum of the spleen and divides in to five or more segmental branches. Besides branches to the spleen, the splenic artery gives off pancreatic, short gastric and left gastro-epiploic arteries. The left gastroepiploic artery anastomose with right gastroepiploic artery along the greater curvature of the stomach.

This type of branching pattern of coeliac trunk was seen in 12 cases (40%).

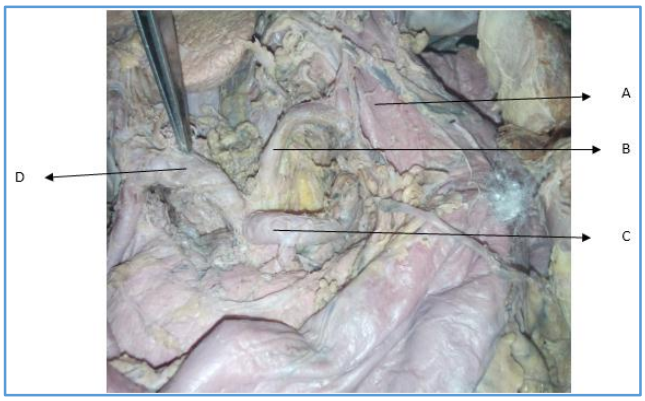

Figure 1. Normal Trifurcation

A. Lesser Curvature of Stomach,
B. Left Gastric Artery
C. Splenic Artery,
D. Common Hepatic Artery.

Variations of Coeliac Trunk

In this study 60% cases shows variations. It includes

1. Trifurcation with variation in the branching pattern.
2. Origin of IPA (inferior phrenic arteries) from celiac trunk.
3. Absence of coeliac trunk.
4. Mode of origin.

Trifurcation with Variation in the Branching Pattern

The coeliac artery was divided into left gastric, common hepatic and splenic artery. But variation in the arrangement are observed in 5 cases (16.7%), of which cystic artery arise from common hepatic artery in 4 cases and right gastric artery arises from left branch of the hepatic artery in 1 case. In a complete coeliac trunk shows all 3 branches were seen, but their division shows variation from the normal pattern. In incomplete coeliac trunk shows one or more branches were absent. In an absent coeliac trunk shows all branches arising from abdominal aorta directly (Table 1 and chart 1).

No. of Subjects Examined	Coeliac axis Complete	Coeliac axis Incomplete	Absent
30	27	2	1

Table 1. Variation in the Branching Pattern

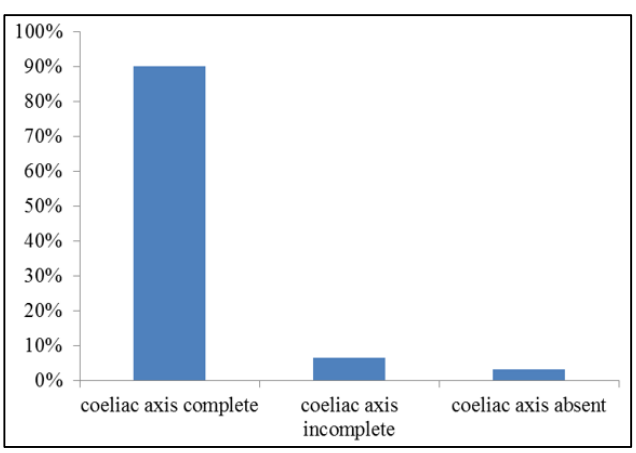

Chart 1. Showing Variation in Branching Pattern

Origin of IPA (Inferior Phrenic Arteries) from Coeliac Trunk

The inferior phrenic arteries constitute a pair of important vessels supplying multiple organs including the diaphragm, adrenal glands, oesophagus, stomach, liver, inferior venacava and retroperitoneum. In majority of cases the right inferior phrenic arteries originate as separate vessels from abdominal aorta. In the present study it arises from coeliac trunk in 2 cases (6.6 %) (Figure 2). The left inferior phrenic artery arising from coeliac trunk in 3 cases (10%) (Figure 3), and both right and left inferior phrenic artery can arise in the form of common trunk from coeliac trunk in 2 cases (6.6%).

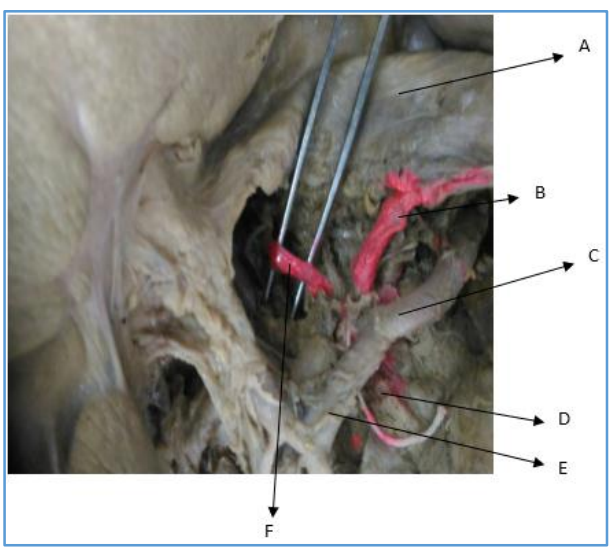

Figure 2. Coeliac Trunk. Origin of Right Inferior Phrenic Artery

A. Lesser curvature of stomach,
B. Left gastric artery,
C. Splenic artery
D. Abdominal aorta,
E. Common hepatic artery,
F. Right inferior phrenic artery.

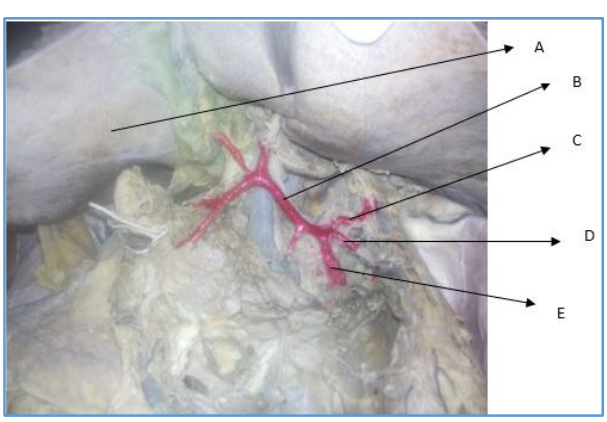

Figure 3. Coeliac Trunk- Origin of Left Inferior Phrenic Artery

A. Liver,
B. Common hepatic artery,
C. Left inferior phrenic artery
D. Left gastric artery,
E. Splenic artery.

Absence of Coeliac Trunk

The absence of coeliac trunk was noticed in 1 specimen (3.3%). The arteries were seen originating from abdominal aorta separately (Figure 4).

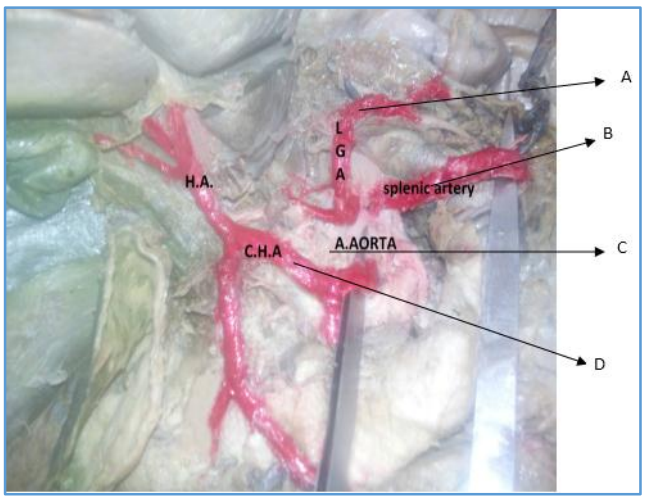

Figure 4. Coeliac trunk- Agenesis

A. Left gastric artery,
B. Splenic artery,
C. Abdominal aorta
D. Common hepatic artery.

Variation in the Mode of Origin

Coeliac artery was the common trunk for the origin of left gastric, splenic and hepatic arteries. The hepatic and splenic artery arose from the coeliac trunk but left gastric artery has a varied origin from abdominal aorta in 2 cases (6.6%) (Fig 5). Another 2 cases (6.6%) the gastric and hepatic arteries took origin from coeliac axis, but the splenic artery arise from the abdominal aorta. In 1 case (3.3 %), hepatomesenteric trunk and gastrosplenic trunk originate from coeliac trunk and each divide and enters the respective organs (Figure 6).

Figure 5. Left gastric Artery and Hepato-splenic Trunk

A. Abdominal aorta,
B. Left gastric artery,
C. Splenic artery,
D. Common hepatic artery.

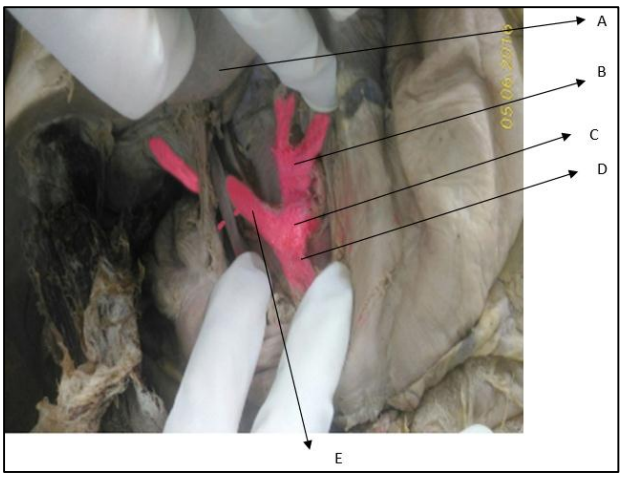

Figure 6. Gastro-splenic Trunk and Hepato-Mesenteric Trunk

A. Liver,
B. Common trunk for left gastric and splenic artery
C. Common trunk for common hepatic and Superior mesenteric artery
D. Superior mesenteric artery,
E. Common hepatic artery.

DISCUSSION

The extreme degree of variability in the coeliac trunk as brought out in the observations of the present study almost falls in description with previous studies. The clinical relevance of these varying arterial types provokes the interest of anatomists on their development and tries to contribute their knowledge to the benefit of the clinical fraternity.

The present study which was conducted on thirty cadavers have 40% normal arterial pattern of coeliac trunk. Previous studies have shown 54.7% to 56% normal pattern.[4] The comparatively higher percentage of the so called normal coeliac trunk in some studies could probably due to the fact that many authors did not consider certain details like presence of inferior phrenic artery, variations in the branching pattern of coeliac trunk.

In our study 60% of the coeliac trunk shows variations. A complete absence of coeliac trunk was observed in one case. Most of the studies in literature revealed a major bulk of their variations in the branching pattern, similar to the present study. According to Moncada et. al., 89% of the coeliac arteries divide in to left gastric, common hepatic and splenic arteries but variation seen in the arrangement are quite common. Vandamme and Bonte in their angiographic study showed that only 86% of coeliac trunk showed the classical trifurcation whereas Michels stated this percentage to be only 55%. Present study it was observed that 60% of coeliac trunk shows different types of variations. Trifurcation with variation of branching pattern showed 16.7%, origin of inferior phrenic (right, left, both) 23.32%, absent trunk 3.33 %, variation in the mode of origin 16.65%.

However all the variations of branching pattern of coeliac trunk reported so far have not been described in classification given by Lipshutz, Adachi, Michels, and

Uflacker. The additional branches of the trunk reported in literature include the inferior phrenic artery, superior mesenteric artery, gastroduodenal artery, middle colic artery, dorsal pancreatic artery. According to Song et. al., fifteen types of coeliac trunk variations including normal coeliac trunk are theoretically possible and they identified thirteen types in 5002 patients using spiral computed tomography and digital subtraction angiography.

Absence of coeliac trunk is very uncommon. In past various studies and case reports have observed the incidence of absent coeliac trunk. Rossi and Cova.[5] observed 1.96% incidence in 102 specimens. The present study showed absence coeliac trunk in 1 case out of 30 cases (3.3%). His finding is almost agree with the study of T Picquand.[6] in 50 cadavers showing 2% without coeliac trunk. Morettin et al.[7] reported a case of congenital absence of coeliac trunk on intravenous abdominal aortography, later surgically confirmed.

The inferior phrenic arteries (IPA) constitute a pair of important vessels, supplying multiple organs including the diaphragm, adrenal glands, oesophagus, stomach, liver, inferior venacava and retroperitoneum.[8] The vast majority of inferior phrenic arteries originate as separate vessels either from abdominal aorta or the coeliac trunk. Infrequently the right and left inferior phrenic arteries can arise in the form of a common trunk from the aorta or the coeliac trunk.[9] The present study it was seen in 7 cases out of 30 cases (23.31%) was arising from coeliac trunk. A total study of 383 computed tomography images by Gwon.[10] showed that the site of IPA origin was the coeliac trunk and aorta in 152 and 148 cases, respectively. The IPA is the most common source of extra hepatic collateral blood supply for Hepatocellular carcinoma (HCC) located in the bare area of liver. The knowledge of the arterial anatomical variations is very important for clinical, radiological and surgical diagnosis.[11] The anomalous origin of cystic artery from the common hepatic artery, hepatomesenteric trunk and gastrosplenic trunk are consistent with embryological basis.

CONCLUSION

Anatomical variations of the coeliac trunk are due to the developmental changes in the ventral segmental (splanchnic arteries). Presence of additional arteries may provide collateral circulation which may be important during transplant surgeries. Anatomical variations in the branching pattern of coeliac trunk are of considerable importance in liver transplants, laparoscopic surgery, radiological abdominal interventions and penetrating injuries to the abdomen. In the present article the data derived from earlier research has been consolidated to give an account of the majority of the variations reported in the anatomy of the coeliac trunk. All these variations have embryological basis in their distribution pattern since this artery is the artery of foregut.

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